Assessing the performance of stormwater treatment systems in the field

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With significant investments being made in stormwater infrastructure in all of Australia's major urban centres, it is important to be able to demonstrate that this infrastructure is operating effectively and meeting its intended performance goals. Performance assessment can also help operators foresee potential issues which require rectification, and can help stormwater managers and the industry as a whole to learn from past failures and avoid repeated mistakes. However monitoring pollutant load removal is a costly and time-consuming exercise. Our industry has a need for pragmatic performance assessment tools which can be used both rapidly and cost-effectively.

The authors have undertaken a number of projects involving rapid field assessment of treatment system condition to assess performance. While the techniques used have been simple, the results have been powerful, helping to highlight issues, uncover the reasons for poor performance and inform options for improvement. This could include both physical works to improve the performance of individual treatment systems, as well as organisational changes to improve processes for planning, designing, building and operating all treatment systems.

EXTENDED ABSTRACT

A common criticism of contemporary stormwater treatment techniques is that there is no (or limited) monitoring of treatment system performance post-construction. Governments and private developers are making significant investments in stormwater treatment systems, and as this level of investment increases, there are increasing calls to monitor the effectiveness of these investments.

Stormwater treatment systems are commonly designed to meet load-based pollutant targets. However assessing performance against these targets can be a costly exercise in event-based monitoring, extensive laboratory testing and statistical data analysis. This type of assessment is typically financially and technically out of reach for most operators of stormwater treatment systems. Therefore often, the industry response is to fall back on predictive modelling to provide estimates of pollutant load removal performance.

Predictive modelling is based on field monitoring of treatment systems and therefore is an ideal conceptual design tool, however there are several issues with using predictive models *in lieu* of performance monitoring:

- Stormwater treatment models involve significant simplifications of complex processes, and for this reason, local conditions may not be adequately represented in the model
- Stormwater treatment models assume that systems have been constructed according to specifications and maintained in good working order, which is not always true
- This approach fails to satisfy critical scrutiny or live up to the standards expected of comparable public investments

Therefore there is a need for pragmatic performance assessment tools which can be used both rapidly and cost-effectively. Performance assessment tools need to be simple, but robust enough to stand up to critical scrutiny and answer important performance-related questions.

Performance assessment tools should help to answer questions such as:

- What type of treatment systems are working most effectively
- Where systems are underperforming, exactly what has failed and why?
- What are the options for improving existing systems to function more effectively?
- Where improvements could be made in existing processes including planning, design, construction, establishment, operation and maintenance

Performance assessment methods are discussed in the following sections. While the methods discussed here do not provide quantitative information on treatment system performance, they are able to provide a rapid, high-level qualitative assessment of treatment system function. Wet weather site inspections in particular are a vital tool, which should be utilised prior to any quantitative performance assessment (e.g. monitoring studies), as they quickly highlight major hydraulic issues. There is limited value in attempting quantitative assessment of a treatment system which doesn't function at the macro scale, however the wet weather site inspections allowed identification of selected treatment systems in this study where quantitative assessment would be worthwhile.

Quantitative performance assessment is expensive, particularly where the goal is to quantify pollutant load removal in stormwater treatment systems. While quantitative performance assessment still has a place in verifying performance against specific targets, this project has shown the value in simple qualitative performance assessment tools including wet weather site inspections. It has also highlighted the significant performance knowledge held by operations and maintenance staff, which was drawn out via joint site inspections and interviews.

Desktop review

Existing documentation can be used to establish the physical context around each asset. For example, this should include catchment plans, design drawings and reports, construction documentation, maintenance records and monitoring data. This information is helpful to:

- Understand the original design and intended function of each asset
- Establish the original performance objectives
- Understand the context of the asset within its catchment, within a treatment train and within a land development timeline (where relevant)
- Check design against current best practice standards
- Check written maintenance records (where available)
- Gather information on costs (where available)
- Understand current and past performance issues which have been documented, and
- Understand previous studies (where available) which looked at asset condition and performance.

Interviews

Interviews can be a useful step in drawing out local knowledge and understanding the institutional context around the processes of planning, design, construction, establishment, asset handover, operation and maintenance. Interviews should include staff involved in each stage of an asset's life cycle and could also include private sector players (e.g. the design consultant and construction contractor).

An understanding of the institutional context provides crucial information to inform potential technical solutions. There is little benefit in implementing physical rectification works if the same issues are likely to be repeated (e.g. operation and maintenance service levels can't be increased), however in other cases the original causes of system failure (e.g. construction stage sediment loads) are no longer present.

Interviews are therefore helpful to understand:

- Processes for planning, design, construction, operation and maintenance of different types of stormwater treatment systems (e.g. old systems, recent retrofits, greenfield subdivisions)
- Asset management and maintenance arrangements for stormwater treatment systems
- Roles and responsibilities in relation to stormwater treatment systems
- Procedures (e.g. written records)

- The history and context around particular systems
- Perceived performance problems
- Ideas to improve ongoing performance

Site inspections with maintenance staff

Site visits with maintenance staff are useful to understand site-specific issues, performance history and preferences for certain design features. Site visits should be used to discuss:

- How maintenance is carried out
- Common problems encountered at the maintenance stage
- Key issues which require frequent maintenance or cause maintenance issues
- Aspects which have been modified since design and construction
- Asset history and potential reasons behind issues such as vegetation failure

Informal discussions on site can help in understanding the challenges faced in the field maintaining WSUD assets. Staff can point out key issues (e.g. where debris tends to accumulate, where they need access) and key features (e.g. where previous rectification/renewal/replacement works had been undertaken), highlight what works and what doesn't, why they prefer some features over others and where they currently face particular challenges.

Wet weather site inspections

Wet weather site inspections are a critical part of performance assessment. Wet weather site inspections can quickly reveal exactly how a stormwater treatment system is functioning on a macro scale ï i.e. how water is moving in, out and through the system. Wet weather site inspections are very useful to rapidly assess whether a system is working from a hydraulic perspective.

Specifically, wet weather site inspections allow an experienced reviewer to:

- Check whether structures and physical features are working as expected (e.g. inlets, outlets, overflow structures)
- See whether flow diversion structures are working effectively, and
- See where there are preferential flowpaths, short-circuiting, bypassing or õdeadò zones in treatment systems.

This rapid assessment of the hydraulic performance cannot confirm pollutant removal performance, but does provide a good indication of whether a treatment system is meeting its design intent and broad performance objectives.